Future demands on the gas infrastructure

Summary

With the Energy Agreement of 22 March 2012 it was decided that, among other things, solid foundations needed to be laid for transforming the energy supply into one which would be fully powered by renewable energy in the future. Such a task could only be accomplished with an adequate knowledge base supported by the most economical and efficientsolutions. As part of this approach, the DEA was asked to prepare an analysis of the future demands on the gas infrastructure, both in the transitional phase of the continued use of natural gas and in a future where biogas and other renewable gases take precedence.

The Danish Energy Authority's analysis was carried out in co-operation with Energinet.dk and the three gas distribution companies have contributed to the analysis.

As part of the Energy Agreement it was agreed, that analyses should be conducted for the electricity system, the role of district heating in the future energy supply and an analysis of the future use of bioenergy in Denmark. As a common backgroud for conducting the analyses, it is considered appropriate to apply the common preconditions and scenarios that would seem most likely in future energy systems. The scenarios are technically consistent models or pictures of possible future energy systems in Denmark that fall in line with the policy objectives.

The overall purpose of the analysis of the gas infrastructure is to examinate the effects on the gas infrastructure of a drop in both the absolute and relative share of natural gas in the national energymix.

This will take place as consequence of the government's goal, that electricity and heat supply must solely be based on renewable energy by 2035 and that the entire energy supply comes from renewable energy by 2050. As the cost of operation of the gas transportation system are more or less independent of the transported gas volumes, all else being equal, this will lead to increased transport prices per Nm3 of transported gas.

Similar to the rest of the energy system, the role of the Danish gas system is likely to change considerably over the next decades. The flexibility in the existing system could be made available to the overall energy system and thereby contribute to higher security of supply, for example, to cover peak-load demand in electricity and heat production, process energy in the industry sector and in the transport sector.

The gas system ensures continued production and revenues from gas exploitation in the North Sea. The Expectations for the future production of saleable gas (gas production less that consumed on the platforms) has been calculated on the basis of proven reserves in the Danish Energy Authority's forecast from 2013. If the calculations include possible contributions from additional production at existing fields due to technological developments and contributions from new discoveries in connection with explorations, there may be a need to transport additional volumes of gas through the gas infrastructure.

The volumes of renewable energy gases are, in any given scenario, limited to the volume which is assumed to be possible to obtain from biogas plants, in some cases upgraded with hydrogen. These limited quantities mean that the gas must be targeted to at the areas of use where it is assumed to have the greatest usefulness in a fossil-free energy supply. The basis for this is provided by a socio-economic analysis which has assessed in future to be on transport, industry and the fast regulating electric production plants. Therefore, it is assumed that gas will be essentially phased out for other uses, including heat production.

This means that the use of gas is assumed to change significantly compared with today in the overall energy scenarios up to 2020, 2035 and 2050. For 2035, the scenarios therefore contain a dramatic drop in gas consumption, which means the gas infrastructure will need to manage less transportation volume. However, the costs of operating the gas infrastructure are not reduced proportionately to the gas volume, because the costs are very much independent of the volumes transported. All else being equal, the transportation price per Nm3 will therefore increase due to reduced Danish gas consumption.

It is assumed that up to 2035 production of renewable energy gases can be built up to replace natural gas, however there is no specific recommendation as to how and when this should take place. Developments will depend to a great extent on the market, unless there is some extent of subsidies for renewable energy production.

In overall terms, it appears essential for the overall energy system that most of both gas transmission and gas distribution systems are maintained in order to secure a system that can handle connection of future renewable gas plants, gas filling stations for transport, the continued supply of gas for the process industry and as well as delivery of flexibility and back-up for the electricity system.

The Danish Energy Authority's overall scenario analysis shows that it is possible to construct energy systems that meet the policy objectives for an energy supply based on renewables. Furthermore, the overall scenarios show that the gas infrastructure in 2050 can be used for the transportation and storage of energy (renewable energy gases) and to ensure the security of the energy supply.

In the light of the significant uncertainties associated with analyses of the energy systems of the future, not least with regards to developments abroad, expected technological development and the trend in fuel prices, it seems to be more or less essential for a cost-effective conversion of the Danish energy system that the energy system is designed in such a way that it is resilient to unexpected developments and yet at the same time to allow for the integration of new technologies.

The analysis draw up a picture of a gas system that can increasingly be used for the green transition, including distribution of renewable energy gases, which in step with the technological development are likely to gradual replace natural gas in the Danish gas market. The overall scenarios assume continuously increased use of renewable energy gases during the period from 2020 in order to replace natural gas in the energy supply. Today, biogas is the most competitively mature form of renewable energy gas, but the production price of biogas is still 2-3 times more expensive than natural gas. Other forms of renewable energy gas, such as gas from the thermal gasification of biomass, waste and electrolysis gas are still only at the research and development stage. However, it is expected that gasification technologies can be made more competitive up to 2025.

There seems therefore to be a need for significant parts of the gas system in the future. If the objective of fossil independent heat and electricity production is to be met by 2035, this means that, among

other things, gas consumption for individual heating must be phased out by 2035. This means that parts of the distribution network can be closed down and cost savings will be achieved, primarily due to the fewer customers. However, this may later lead to reduced degrees of freedom and extra costs of connection biogas plants and gas filling stations for the transport sector to the system.

The technical possibilities and the economic costs of a possible conversion of gas consumption in Danish businesses and industries to electricity or a carbon-neutral fuel have been examined. The result reveals that up to 90 % of the potential gas consumption examined is assessed to be technically apt for conversion to another technology. The total capital costs of replacing natural gas today with electricity or biofuels will, for gas-consuming process companies, lie in the range of DKK 19-28 billion in current prices.

It should be noted that the analysis does not include an assessment of the operating costs of conversion. A shift away from natural gas could have a negative impact on industry competitiveness, especially in comparison to other European countries where natural gas has been preserved as a central part of the energy system.

From a socio-economic point of view, provided that renewable energy gases replace natural gas as assumed in the Danish Energy Agency's scenarios, there could be a clear benefit from exploiting the existing gas system. Thus, the gas system could then be used in the green transition of the energy system, i.e. by distribution of renewable energy gases to the Danish gas market.

Renewable energy gas can be produced flexibly from biomass, waste and in the long term also from electricity that is based on renewable energy. Natural gas (methane), which to day is being used in the gas network, can integrate a large number of renewable energy gases through upgrading and methanation. There can also be a mix of a certain volume of other gases in the net, but research is still ongoing as regards the proportions of non-upgraded biogas and hydrogen that can be injected into the network. It is also unclear whether plants should be small or large, and this aspect has a great bearing on the infrastructure.

Renewable energy gas can be cheaper and better than other biofuels (bio-ethanol, bio-diesel, etc.) for a large number of uses. It is therefore essential that the gas system makes it possible to route renewable energy gas to uses that are not compatible with a conversion based on renewable energy electricity.

The role of the Danish gas system is expected, as with the other elements of the energy system (power system, heating system and the transport system) to undergo a significant change over the coming decades. The flexibility in the existing gas system could be made available to the overall energy system, and thereby contribute to the security of Danish energy supply in a future renewable-based energy system. Examples of where this would be applicable include meeting demand for peak load electricity and heat production, process energy for industry and the transport sector.

A future challenge will be to determine how the long-term financing and maintenance of the gas system elements, i.e. the transmission, storage and distribution functions, can be ensured when the cost of operation of the gas system have to be covered by lower transport volumes.

The challenges in the transmission system, storage facilities, the distribution system and in relation to consumers, vary considerably. For example, an expected drop in demand for storage services for the Danish and Swedish markets will reduce the earnings potential of the Danish storage companies and

thus prompt the Danish storage companies to focus more extensively on the larger European storage markets. If Danish natural gas storage facilities in 2050 are to offer the same security of supply as today, this could reveal a need to ensuring the economic resources to maintain and preserve operation of the storage facilities.

Today, the distribution companies use tariffs which drop per m^3 of gas distributed to the consumer, i.e. they are proportionate to consumer gas consumption. A loss of all detached-house gas consumers would not occasion a proportionate drop in the costs of operating the gas system and will therefore mean that the remaining gas consumers with large gas consumption have to pay for a larger share of the costs associated with operating the natural gas system than they do today.

The tariffs could also be affected by developments in neighbouring countries. Producers in the North Sea can either supply natural gas to the Netherlands, via the Nogat pipeline, or to Denmark. The producers' choice depends on the transportation costs for the two routes. The Danish transmission tariffs will be affected by the earnings obtainable from the transit of gas through the Danish transmission system to Germany.